

## Introduction

Metastable steels (steels that comprise a meta-stable phase) undergo phase evolution during a mechanical forming process. The metastable phase in austenitic stainless steels is austenite,  $\gamma$ , which transforms into martensite,  $\alpha'$ , under the action of applied strain and stress. The transformation itself causes additional straining of the material and the presence of  $\alpha'$  hardens the material significantly.

## Objective

The aim of this project is to develop a constitutive model that can simulate the mechanical behavior of TRIP steels under complex forming operations.



## Methods

### Thermodynamics

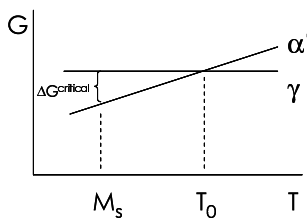
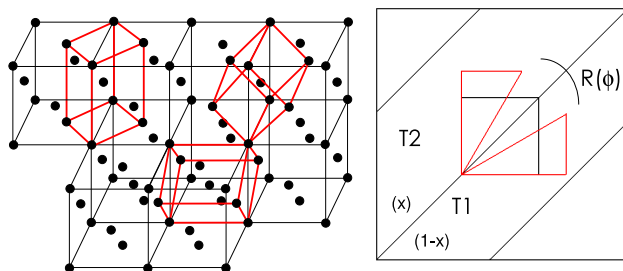


Figure 1 :  $M_s$  and the Gibbs free energy curves of  $\gamma$  and  $\alpha'$  dictate the energy barrier for transformation.

### Crystallography



$$F^{tr} = (1-x)T_1 + xR(\phi)T_2$$

$$\dot{F}^{tr} = I + \dot{\xi}(sn) \Rightarrow W = \sigma : (sn)$$

Figure 2 : Lattice correspondence between  $\gamma$  'fcc' and  $\alpha'$  'bcc' and the transformation mechanism via Bain strain and twinning.

Using the work associated with the transformation of one variant the *mechanical driving force* (MDF) can be estimated over the polycrystal.

## Mechanical tests

### Prestrain

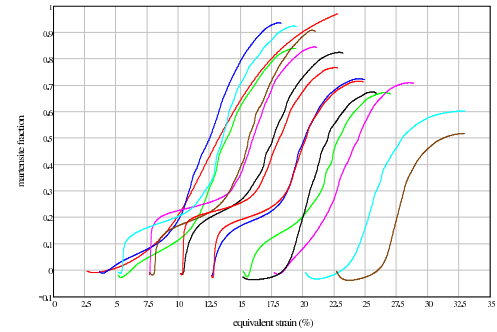


Figure 3 : Effect of transformation-free plastic prestrain on further transformation kinetics.

Using these experimental results the effects of plastic strain on the transformation kinetics are quantitatively investigated.

### Biaxial

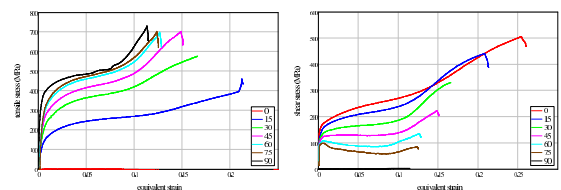
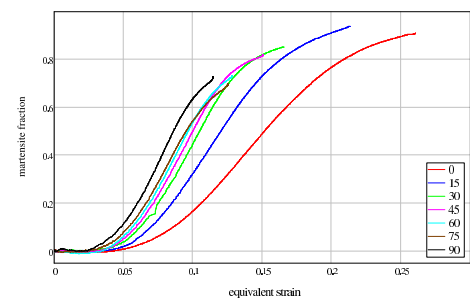


Figure 4 : Effect of hydrostatic stress on transformation kinetics.

The results show that the transformation curves have the same shape with respect to strain and scale in this space linearly with hydrostatic stress.

## Discussion

Mechanical tests quantify the effects of parameters that drive the transformation,  $\epsilon^p$  and  $\sigma$ . Using these results and the thermodynamical findings, phenomenological models will be developed to predict transformation.